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Barrier methods of contraception, spermicides, and sexually transmitted diseases: A review

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Abstract

***Objective*—To understand whether barrier methods of contraception (BMC) and/or spermicides lower the risk of acquiring sexually transmitted disease (STD) and to quantify the protection.**

***Design*—Review of published experimental studies, in vitro and in vivo evidence on the issue.**

***Subjects*—We reviewed 22 papers that examined the impermeability of BMC in vitro against STD agents or the effect of spermicides, and 60 papers reporting results of epidemiological studies on the risk of STD in users of BMC.**

***Results*—There was in vitro evidence that both BMC and spermicides were effective against most sexually transmissible agents. Doubts remain on the effectiveness of BMC and spermicides in normal conditions of use, particularly against human papilloma virus. Natural membrane condoms are not impermeable and pores are seen by electron microscopy. Epidemiological studies show a consistent reduction in the risk for use of condoms against gonococcal (most studies giving relative risk, RR, estimates around 0·4 to 0·6) and HIV infection (RRs between 0·3 and 0·6 in most studies). Spermicides protect women against gonorrhoea and trichomoniasis; their role against other STDs is less clear and there is some indication of an irritative effect on the vaginal mucosa that is likely to be dose-dependent.**

***Conclusions*—A large amount of evidence indicates that BMC reduce the risk of gonorrhoea and HIV transmission, but the results are—at least in quantitative terms—less consistent for other diseases. Implications for individual choices and public health approaches should relate to frequency of exposure and severity of the disease too.**

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Introduction

Barrier methods of contraception (BMC) are non-permeable mechanical and/or chemical devices designed to prevent conception. There is an intuitive feeling that such a barrier between the genitalia during sexual intercourse should reduce the likelihood of acquiring most sexually transmitted diseases (STD). Evidence of the protective effect of BMC on the risk of STD has been published, but there is a lack of quantitative assessment of the protection. This paper, therefore, reviews the main evidence on the issue, with specific focus on the quantitative estimates of risk. Before presenting the epidemiological evidence on the role of BMC on STD, data from laboratory studies are summarised.

LABORATORY STUDIES

Latex condoms are effective mechanical barriers in vitro to prevent the passage of several infective agents, including viruses, such as cytomegalovirus (CMV),[1] human immunodeficiency viruses (HIV),[2–4] hepatitis B Virus (HBV),[5–6] herpes simplex virus type II (HSV-II)[4–7] and chlamydia.[4] Electron microscopy was used to investigate the presence of pores in stretched latex condoms: superficial irregularities were observed, but no actual pores or other defects that could compromise their impermeability.[8] In some studies, condoms were inserted in media infected by various pathogens and were submitted to trauma and stretching to simulate coitus[1 3–6]; they were impermeable to several agents, including CMV,[1] HIV,[3] HBV [5 6] chlamydia[4] and hepatitis B surface Antigen (HBsAg).[5 6] Considerations about the size of viruses and bacteria in comparison with the size of HBsAg are convincing as concerns the effectiveness of these devices, as all sexually transmitted pathogens are bigger. On the other hand, a sophisticated test simulating normal conditions of use detected leakage of HIV-sized particles through as many as 29 of 89 latex condoms tested[9] and recent Food and Drug Administration data indicate that the average batch of condoms has a water-leak rate of 0·3%.[10] The role of natural membrane condoms is controversial: in vitro some let viruses through,[5 6 11] and electron microscopy has shown pores.[6]

Spermicides are usually enclosed in media to slow the progression of sperms and occlude the external uterine ostium. Spermicide-impregnated sponges combine the actions of a physical barrier that blocks the cervix with a material that absorbs ejaculate, and a spermicide.[12] Spermicides are not a single class of chemicals. For instance, nonoxynol-9 (N-9) is classified as a surfactant,[13] while benzalkonium chloride is a disinfectant[13] and phenylmercuric acetate is an organic mercurial compound (aryl mercurial).[14]

In vitro benzalkonium chloride has a direct inhibitory effect on HIV[15] and N-9 inhibits the growth of several infective agents, such as *Treponema pallidum*,[16] *Neisseria gonorrhoeae*,[16]

Chlamydia trachomatis,[4 17 18] HSV [4 19] and CMV[20] but not bovine papilloma virus (BPV-1) and BK Virus (BKV).[20] As BPV-1 is closely related to HPV, it is reasonable to assume that N-9 does not inactivate the latter either.

At the concentrations usually used for spermicidal effect N-9 is highly effective in vitro against HIV and HIV-infected cultures of human lymphocytes[21-23] and foams and gels containing N-9 prevented genital transmission of simian immunodeficiency virus (SIV) in rhesus macaques.[24]

Doubts remain about the amount of spermicide in commercially available condoms[25] and whether the concentration after the rupture of standard devices during sexual intercourse is sufficient to kill pathogens in vivo.[3 25] It has also been suggested that the use of N-9 may disrupt the vaginal epithelium,[26 27] making infection easier. Chlorexidine is now under study as a spermicide: it is less irritant on mucosal cells than N-9.[28]

Evidence is available about mineral-based lubricants being erroneously used with latex condoms. The resistance of the condoms is severely lowered and the risk of breakage becomes very high.[29 30] Despite instructions that mineral lubricants such as vaseline must not be used, the products usually used to facilitate sexual intercourse are often mistakenly thought to be water-based.[29] New condoms made of polyurethane are currently being tested. They can be used with lubricants that attack and break down latex condoms and are less likely to deteriorate in storage.[30-32] No study has tested diaphragms in vitro to check their impermeability to pathogens. Probably their thickness has always been considered a strong argument in their favour and the real risk is that ejaculate may pass round under the edges without being inactivated by the spermicide used simultaneously.

EPIDEMIOLOGICAL STUDIES

Epidemiological studies and clinical trials should provide quantitative estimates of the protection of BMC users and indicate which factors affect the level of protection. They should also indicate the method that combines the highest level of protection, ease of use and acceptability, in order to promote their use in preventive campaigns.

In principle, all STDs are preventable by barrier methods. Most studies, however, have focused on one or two STDs only. In general, little information is available on unusual infections in western countries, such as lymphogranuloma venereum and cancroid. Our presentation will deal first with gonorrhoea and non-gonococcal urethritis, then with HIV infection, and finally with the other STD. Separately we review the evidence about condoms or diaphragms, and data on spermicides. Studies were sought by reviewing reference lists in relevant papers and by manual and computer (MEDLINE) searches of the papers published in English since 1970. We collected a total of 60 papers that reported information of interest.[33-92] If the authors did not report odds ratios (OR) and 95% confidence intervals (CIs), we estimated them from published data, whenever possible.

BARRIER METHODS OF CONTRACEPTION

Gonorrhoea

Table 1 summarises evidence from selected studies on barrier methods of contraception (BMC) and gonococcal infection. Results are generally consistent in favour of some protection for BMC users in comparison with non-users. Females whose partners use condoms have an OR of gonococcal infection ranging from 0·4 to 0·9. Male condom users themselves are protected against gonococcal infection, estimated OR ranging from 0·3 to 0·9.

One study also presented the results for

Table 1 Main results from selected studies on the efficacy of barrier methods of contraception (BMC) for the prevention of gonorrhoea

Authors (Country)	*Type of study*	*Setting*	*Main results*
CONDOM—results for females			
Allen *et al* (Rwanda)[33]	Cohort	HIV-positive women at a research clinic	Protection ($p < 0.05$)
Austin *et al* (USA)[34]	Case-control	STD clinic	RR* = 0·9 (0·7–1·1)† RR = 0·4 (0·2–0·8)†‡
Rosenberg *et al* (USA)[35]	Retrospective	STD clinic	RR = 0·6 (0·5–0·8)†
Swaddiwudhipong *et al* (Thailand)[36]	Cross-sectional	Prostitutes in a country district	Protection ($p < 0.05$)
Upchurch *et al* (USA)[37]	Cross-sectional	STD clinic	RR = 0·4 (0·2–0·9)
CONDOM—results for males			
Barlow (UK)[38]	Cross-sectional	STD clinic	RR = 0·6 (0·4–0·9)
Darrow (USA)[39]	Perspective	STD clinic	RR = 0·9 (0·0–20·9)
Hooper *et al* (Far East)[40]	Cohort	"Shipboard STD clinic"	Protection (p = n.s.)
Pemberton *et al* (Ireland)[41]	Cross-sectional	STD clinic	RR = 0·4 (0·2–0·8)
Upchurch *et al* (USA)[37]	Cross-sectional	STD clinic	RR = 0·7 (0·4–1·1)
CONDOM—cumulative results for females and males			
Upchurch *et al* (USA)[37]	Cross-sectional	STD clinic	RR = 1·2 (0·9–1·8)
DIAPHRAGM—results for females			
Austin *et al* (USA)[34]	Case-control	STD clinic	RR = 0·5 (0·2–1·3)‡
Bradbeer *et al* (Singapore)[42]	Cross-sectional	Prostitutes at a genitourinary clinic	Protection ($p < 0.05$)
Rosenberg *et al* (USA)[35]	Retrospective	STD clinic	RR = 0·3 (0·2–0·7)†
BMC NOT SPECIFIED—results for females			
Berger *et al* (USA)[43]	Cross-sectional	Family planning clinic	RR = 0·4 (0·1–1·5)
Quinn & O'Reilly (USA)[44]	Cross-sectional	STD clinic	RR = 0·1 (0·1–0·2)

*RR = Relative Risk. If not otherwise specified it is followed by 95% Confidence Intervals in brackets.
†90% Confidence Interval in brackets.
‡BMC with spermicide.

Table 2 Main results from selected studies on the efficacy of barrier methods of contraception (BMC) for the prevention of non-gonococcal urethritis or cervical infections

Authors (Country)	*Type of study*	*Setting*	*Main results*
CONDOM—results for females			
Pemberton *et al* (Ireland)[41]	Cross-sectional	STD clinic	RR* = 1·3 (0·8–2·1)
Rosenberg *et al*[35] —results for males	Retrospective	STD clinic	RR = 0·9 (0·6–1·4)†
Barlow (UK)[38]	Cross-sectional	STD clinic	RR = 1·0 (0·7–1·4)
McCormack *et al* (USA)[45]	Cross-sectional	University students	RR = 0·2 (0·1–0·6)
DIAPHRAGM—results for females			
Magder *et al* (USA)[46]	Cross-sectional	STD clinic	RR = 0·0 (p < 0·001)
Rosenberg *et al* (USA)[35]	Retrospective	STD clinic	RR = 0·3 (0·1–1·4)†
BMC ALTOGETHER—results for females			
Harrison *et al* (USA)[47]	Cross-sectional (nested in a trial)	University gynecology clinic	RR = 0·2 (0·0–0·9)
McCormack *et al* (USA)[48]	Cross-sectional	University gynecology clinic	RR = 0·1 (0·0–0·8)

*RR = Relative Risk. If not otherwise specified it is followed by 95% Confidence Interval in brackets.
†90% Confidence Interval in brackets.

"correct" and "incorrect" users of condoms: the estimated OR were respectively 0·2 (95% CI, 0·1–0·6) and 0·9 (95% CI 0·5–1·7) in comparison with non-users.[38] Another analysed the effect of condoms considering males and females together; no protective effect emerged.[37]

The diaphragm protects women against gonococcal infection. Rosenberg *et al* found a 70% lower rate of infection for diaphragm users in comparison with no method of contraception, and a 50% lower risk for diaphragm and sponge users in comparison with condom users.[35] A protective effect of the diaphragm was also reported in a study conducted on prostitutes in Singapore.[42] Two studies that did not separate the effects of diaphragm, condom or foam on the risk of STD infection showed reduced OR in BMC users in comparison with non-users (0·1 in the study by Quinn and O'Reilly[44] and 0·5 (non-significant) in the study by Berger *et al*.[43])

Non-gonococcal urethritis and cervical infections

These diseases are considered in Table 2. Two studies analysed the role of condom on female risk of non-gonococcal urethritis: no protection emerged.[35 41] The estimated OR were 0·8 (non-significant) and 0·3 (95% CI 0·2–0·7) in the two studies analysing the effect of condoms on the risk of non-gonococcal urethritis in males.[38 45] A protective effect of the diaphragm on non-gonococcal infections in women emerged in two studies conducted in the USA.[35 46] Likewise OR were 0·1 and 0·2 (statistically significant) in the two studies that analysed the role of BMC altogether.[47 48] These findings were consistent considering separately the available data for chlamydiae and *Ureaplasma urealithicum*.

HIV

We reviewed 21 papers published since 1987 on the efficacy of condoms against HIV infection (table 3). Fifteen presented data on the risk of female infection (one included the risk of male infection during heterosexual intercourse, too), two on male infection during homosexual intercourse and three did not separate the risk of male and female infection.

With reference to females, all but two studies[58 62] reported some protective effect of condom use, the OR ranging from 0·0 to 0·9. Only one study conducted at a STD clinic in Kenya[58] found no protection. In this study the risk for condom users was more than doubled, but the multivariate estimate was significant only for data on prostitutes, probably because the women who perceived themselves at risk of acquiring HIV were more likely to use condoms. However, no woman reported 100% use. No information was provided on the use of spermicides with condoms, or whether spermicidally lubricated condoms were used.

Spouses of haemophiliacs who used condoms were protected against HIV infection in comparison with spouses whose partner did not use condoms,[51 54 60] and a significant trend emerged of decreasing risk with increasing compliance in condom use.[54]

One study that analysed the risk of female to male infection during sexual intercourse reported protection associated with condom use,[49] but a Thai study on conscripts found a significantly higher risk of infection for those who ever used condoms with commercial sex workers in comparison with never users.[64]

Protection for condom users was found in the two studies that analysed the male to male transmission during homosexual intercourse.[63 65] One of these presented results separately for insertive and receptive anal sex and for the risk of vaginal sex among bisexual males: in all cases significant protection was observed.[63]

Finally, protection from HIV infection was associated with condom use in one cohort study of spouses of HIV-positive subjects[66] and in a cross-sectional study of intravenous drug users (IVDU) attending detoxication centres[67]; no protection was observed in another study including IVDU recruited in the streets of two US cities.[68]

Other sexually transmitted diseases

There are many papers offering evidence of the efficacy of BMC against infection with other sexually transmissible agents. We present their main results here (data not shown in table).

Miscellaneous vaginal infections One study gave results for condom use on the risk of vaginal trichomoniasis, vaginal candidiasis

Table 3 Main results from selected studies on the efficacy of barrier methods of contraception (BMC) for the prevention of human immunodeficiency virus type 1 (HIV-1) infection

Authors (Country)	*Type of study*	*Setting*	*Main results*
RESULTS FOR FEMALES			
Allen *et al* (Rwanda)[49]	Cohort	Couples with discordant serology	RR* = 0·2 (0·0–1·9)
Darrow *et al* (USA)[39]	Cross-sectional	Multicentric study on prostitutes	RR = 0·9 (0·3–2·9)
European Working Group (Europe)[50]	Cross-sectional	Multicentric study on prostitutes	RR = 0·0 (0·0–0·7)† RR = 0·3 (0·1–0·8)‡
Hewlett *et al* (France)[51]	Retrospective	Partners of HIV-positive hemophiliacs	RR = 0·1 (0·0-0·7)
Kanki *et al* (Senegal)[52]	Cohort	Prostitutes attending STD clinics in three towns	RR = 0·3 (0·1–0·8)§
Laga *et al* (Zaire)[53]	Case-control	Health center for prostitutes	RR = 0·4 (0·2–1·0)
Lazzarin, *et al* (Italy)[54]	Cross-sectional	Partners of HIV-positive hemophiliacs	RR = 0·3 (0·1-1·0)† RR = 0·7 (0·3–1·6)‡‖
Mann *et al* (Zaire)[55]	Cross-sectional	Study on HIV prevalence among prostitutes	Protection (p = 0·046)
Ngugi *et al* (Kenya)[56]	Cohort	Community meetings for prostitutes	RR = 0·3 (0·1–0·9)‖
Nzila *et al* (Zaire)[57]	Cross-sectional	Health center for prostitutes	RR = 0·6 (0·4–0·9)
Plourde *et al* (Kenya)[58]	Cross-sectional	STD clinic	RR = 2·3 (1·7-.3·1) RR = 1·3 (0·9-2·1)**
Plummer *et al* (Kenya)[59]	Cohort	Study on STD among prostitutes	RR = 0·1 (0·1–0·3)
Roumelioutou *et al* (Greece)[60]	Cross-sectional	Partners of HIV-positive hemophiliacs	Protection (p < 0·01)
Saracco *et al* (Italy)[61]	Cohort	Partners of HIV-positive men	RR = 0·1 (0·0-0·5)
Zekeng *et al* (Cameroon)[62]	Cohort	Prospective study on prostitutes	RR = 1·1 (0·4–2·9)
RESULTS FOR MALES			
Allen *et al* (Rwanda)[49]	Cohort	Couples with discordant serology	Protection (p = 0·01)
Hernandez *et al* (Mexico)[63]	Cross-sectional	Homosexual men at a reference HIV testing clinic	Protection (p < 0·05)
Nelson *et al* (Thailand)[64]	Cross-sectional	Conscripts at two military training bases	RR = 1·8 (1·3–2·6)
Schechter *et al* (Canada)[65]	Prospective	Study on HIV positive homosexuals from general practices	Protection (p < 0·07)
RESULTS FOR FEMALES AND MALES ALTOGETHER			
Fische *et al* (USA)[66]	Cohort	Spouses of HIV-positive subjects	RR = 0·1 (0·0–0·6)
Nicolosi *et al* (Italy)[67]	Cross-sectional (a) and cohort (b)	Intravenous drug users at detoxication centers	RR = 0·6 (0·2–2·2)(a) RR = 0·3 (0·1–0·8)(b)
Siegal *et al* (USA)[68]	Cross-sectional	Intravenous drug users recruited from streets	RR = 2·1 (0·6–7·8)

*RR = Relative Risk (95% Confidence Interval).
†Always users.
‡Sometimes users.
§Relative risk for HIV-2 infection.
‖Decreasing risk with increasing compliance of use (p < 0·05).
**Nonprostitutes only.

and bacterial vaginosis:[35] no significant protection emerged. This study also gave results about diaphragm use on risk of vaginal infections: an 80% reduction of risk was found for trichomoniasis (RR = 0·2; 95%CI = 0·1–0·5), but the risk for condidiasis was almost doubled (RR = 1·8; 95%CI = 1·3–2·7).

Pelvic inflammatory disease Kelaghan *et al* conducted a case-control study on the effect of condom and diaphragm use on pelvic inflammatory disease (PID).[78] In comparison with no method of contraception, women who had used either condom or diaphragm in the three months before admission to hospital for initial episodes of PID were protected (RR = 0·6; 95%CI = 0·5–0·9). The risk of tubal factor infertility was considered among patients with one previous episode of PID who subsequently attempted to conceive: no difference was found between "barrier method" users at the time of PID diagnosis and non-users.[79]

Human papilloma virus Syrianen *et al* reported no relation between HPV infection and condom use in a Finnish case-control study (RR = 1·4; 95%Cl = 0·7–2·8).[80] Similarly, no difference was noted between condom users and non-users among 198 prostitutes (147 HIV-positive; 51 HIV-negative) in Kenya as regards genital warts and detection of HPV infection.[81]

Hepatitis B virus A survey among female prostitutes in the USA found a reduced risk of HBV infection among black and Hispanic IVDU who used spermicide and/or diaphragm (RR = 0·1; 95%CI = 0·0–0·4 for blacks and RR = 0·2; 95%CI = 0·1–0·9 for Hispanics);[82] no protection was found among white non-Hispanic IVDU prostitutes (RR = 2·1; 95%CI = 0·8–5·5). Among non–IVDU, ever use of a sponge in the past five years was associated with a lower risk of infection (p = 0·01). Use of diaphragm, spermicides or condom was related with a lower prevalence of HBV, but the differences were not significant.

Other infections Considering risk factors for hepatitis C virus (HCV) seropositivity, the OR for females whose partners used condoms was 1·5 (95%CI = 0·6–4·2) in a retrospective study conducted in California on 87 HCV infected subjects and 253 controls.[83] However, a study by Bresters *et al* indicates that the risk of sexual transmission of HCV is nil or very low.[84]

A study based on data obtained interviewing Australian soldiers returning from Vietnam provided evidence of protection with condom use against "self reported" STD, without specifying which diseases were reported.[85] None of the 55 reporting condom use said they had STD, in comparison with 26 of 96 soldiers who did not use condoms

Table 4 Main results from selected studies on the efficacy of spermicides for the prevention of gonorrhoea in females

Authors (Country)	*Type of study*	*Spermicide*	*Setting*	*Main results*
CLINICAL TRIALS				
Cole *et al* (USA)[69]	Community trial	STD clinic	Phenyilmercuric acetate (0·4 mg) pessaries *v* no intervention	Protection (p = 0·003)*
Kreiss *et al* (Kenya)[70]	Randomized, placebo-controlled trial	Prostitutes at a research clinic	Nonoxynol-9 sponge (3%) *v* placebo	RR†=0·4 (p<0·001)‡
Louv *et al* (USA)[71]	Randomized, double-blind, placebo-controlled trial	STD clinic	Nonoxynol-9 jelly *v* placebo	RR = 0·8 (0·6–1·0)§**
Niruthisard *et al* (Thailand)[72] ||	Single-blind randomized trial	Prostitutes in massage parlours	Condom with Nonoxynol-9 *v* condoms with placebo	RR = 0·8 (0·5–1·1)
Rendon *et al* (Mexico)[73]	Randomized, double-blind, placebo-controlled trial	Coordinated Services of Health-Assist.	a) Phenylmercuric acetate, b) nonoxynol-9 *v* placebo	a) RR = 0·3 (0·1–1·1)* b) RR = 0·6 (0·2–1·7)*
Rosenberg *et al* (Thailand)[74]	Randomized comparative clinical trial; unblinded	Mobile STD clinic at massage parlours	Nonoxynol-9 sponge *v* no intervention	RR = 0·3 (0·2–0·8)*
OTHER STUDIES				
Austin *et al* (USA)[34]	Case-control	STD clinic	Unknown	RR = 0·9 (0·5–1·6)§||
Jick *et al* (USA)[75]	a) Retrosp. cohort b) Case-control	Group Health Cooperative	Octoxynol-9 or Nonoxynol-9	a) RR = 0·2 (0·1-0·5)§†† b) RR = 0·1 (0·1–0·3)§††
Quinn & O'Reilly (USA)[44]	Cross-sectional	STD clinic	Unknown	RR = 0·4 (0·3–0·5)*
Rosenberg *et al* (USA)[35]	Retrospective	STD clinic	Sponge	RR = 0·3 (0·1–0·8)§

*No information is provided on simultaneous use of diaphragm or condom.
†RR = Relative Risk. If not otherwise specified it is followed by 95% Confidence Interval in brackets.
‡At least 50% of subjects used condoms.
§90% Confidence Interval in brackets.
||Gonococcal and chlamydial infections altogether.
**No woman used the diaphragm.
††More than 50% of women used the diaphragm.

(p < 0·001). The two groups, however, might have been different for other baseline characteristics, risk attitudes and other selective factors, too.

A significant decrease in genital ulcer disease with increasing frequency of self-reported condom use was reported in a study conducted among prostitutes in Nairobi.[86] Pereira *et al* found no evidence of protection for female BMC users against CMV infection.[87]

SPERMICIDES

Gonorrhoea

Ten papers were retrieved on the efficacy of spermicides on the protection against gonorrhoea (table 4). All concerned females: six were clinical trials and four observational studies. There was a consistent protective effect of spermicides on gonococcal infection. The results from clinical trials showed reduced OR of infection in women who used spermicides in comparison with non-users, ranging from 0·4 to 0·8. OR were lower both in BMC users and non-users. A protective effect of spermicides was also noted in four observational studies,[34 35 44 75] estimated OR ranging from 0·1 to 0·9.

In a randomised clinical trial (RCT) among Thai prostitutes the level of compliance of condom use in women and the OR of infection in spermicide users were inversely related with the risk of STD.[72] In this study, gonococcal and chlamydial cervical infections were considered together, and it was therefore impossible to distinguish the levels of protection for each agent.

Four of six clinical trials reported on adverse effects among spermicide users.[70–73] Studies that investigated prostitutes found a significant increase of genital ulcers and vulvitis among N-9 sponge users,[70] and a 70% higher rate of symptomatic irritation among condom plus N-9 users.[72] Only rare and mild adverse reactions were reported by women in two studies on the general population.[71 73]

HIV

A randomised clinical trial by Kreiss *et al* showed an OR of 1·6 (95%CI = 0·8–2·8) for sponge on the risk of HIV infection among exposed women in comparison with placebo.[70] However, a perspective study by Zekeng *et al* found an OR of 0·1 (95%CI = 0·1–0·6) for more regular compared with less regular N-9 spermicide use among female prostitutes in Cameroon, after adjusting for condom use.[62]

Trichomoniasis, candidiasis and bacterial vaginosis

Spermicides appear to offer protection against trichomoniasis, the estimated OR ranging between 0·3 and 0·4,[34 74 75] but have no effect on bacterial vaginosis (table 5). These findings are consistent in the two RCT and the two retrospective studies. No relationship emerged between spermicide use and risk of

Table 5 Main results from selected studies on the efficacy of spermicides for the prevention of vaginal trichomoniasis, vaginal candidiasis and bacterial vaginosis

Authors (Country)	*Type of study*	*Setting*	*Main results*		
			Trichomoniasis	*Candidiasis*	*Bacterial vaginosis*
Barbone *et al* (USA)[76]	RCT	STD clinic	RR = 0·8 (0·6–1·1)*	RR = 1·0 (0·8–1·4)*	RR = 0·9 (0·7–1·1)*
Feldblum *et al* (USA)[77]	Retrospective	STD clinic	RR = 0·4 (0·2–0·7)*	RR = 0·9 (0·6–1·4)*	RR = 0·7 (0·4–1·0)*
Rosenberg *et al* (Thailand)† [74]	Randomised comparative clinical trial; unblinded	Mobile STD clinic at massage parlours		RR = 2·8 (1·0–8·0)*	
Rosenberg *et al* (USA)† [35]	Retrospective	STD clinic	RR = 0·3 (0·1–0·8)*	RR = 1·2 (0·7–2·1)*	RR = 1·2 (0·6–2·2)*

RR = Relative Risk. If not otherwise specified it is followed by 95% Confidence Interval in brackets.
*90% Confidence Interval in brackets.
†Sponge.

candidiasis, except in a study conducted in Thailand; the risk of infection among spermicide users was almost threefold compared to non-users, reaching borderline statistical significance.[74]

Other sexually transmitted diseases

Hooton *et al* reported that spermicides can seriously alter the vaginal flora.[88] N-9 users had a significantly higher risk of vaginal colonisation with *Escherichia coli*, candida, enterococci and staphylococci than non-users. All these results were based on urine tests; no women developed symptoms of infection. In a previous study Buckley *et al* found no relation between type of birth control method and urinary bacterial counts, but this was not a major end-point of the study, and each subgroup included very few women.[89] One study[90] considered the effect of spermicides on asymptomatic bacteriuria; using the diaphragm with spermicide in the 48 hours before the visit was related to urinary tract infection (UTI) among sexually active females (RR = 8·4; 95%CI = 3·4–21·1); use in the previous 3 to 7 days was less important (RR = 1·8; 95%CI = 0·7–4·7). No specific diaphragm and spermicide type was associated with risk. Cohort and case-control investigations found a significantly increased risk of UTI in diaphragm users.[91] Vaginal colonisation with *Escherichia coli* was significantly more frequent in diaphragm users. Likewise, women using diaphragms had a higher incidence of asymptomatic gram-negative UTI.[92]

N-9 use was associated with a significantly higher frequency of ulcerative genital diseases (RR = 3·3) and vulvitis (RR = 3·3), and with a non-significant reduction of genital warts infection in a RCT in Kenya.[70] The frequency of chlamydial infection was significantly reduced only among women with >50% level of compliance (RR = 0·7; 95%CI = 0·6–0·9). Likewise, the overall reduction in chlamydia incidence was not significant in a Thai RCT on prostitutes.[74] Another study showed non-significant protection for spermicide use against PID (RR = 0·7; 95%CI = 0·4–1·4).[78]

Comment

There is consistent in vitro and epidemiological evidence that condoms and diaphragms are effective preventive measures against several STD. The consistency of the results from epidemiological studies from different populations, and the strength of the associations confirm this. The evidence is stronger for condom use against gonococcal and HIV infection. Data on other STD are scantier, with few quantitative estimates of the protection.

The role of spermicides is less clear. Most studies on spermicides included condom users too, and the RCT on this issue did not show consistent results, except for a potential protection against gonorrhoea and trichomoniasis in females.

Some of the inconsistencies may arise from heterogeneity in study populations outcomes and frequency of BMC use. For example, the only subgroup showing no protection for condoms against gonorrhoea was related to repeated episodes in a study that shows protection for single episodes.[37] It is likely that the lack of protection is restricted to subjects who did not use condoms correctly. Whenever results are presented for "correct" vs "incorrect" or for "always" vs "not always" BMC users, good compliers appear more protected than poor compliers.[38 39 49 54 56 62]

Even if used properly, condoms may not protect against organisms transmitted by external or indirect genital contact. Further, the protection may differ for different brands of condoms. For example, laboratory experiments conducted in Italy by an independent consumer association indicated that only half of the brands of ten thousand condoms purchased in shops passed tests conducted according to International Standard Organisation (ISO) methods, and only one fourth of brands had a "good" evaluation.[93]

Few studies have compared the efficacy of condoms and diaphragms in protection against STD. No randomised trial was found. However, the diaphragm appears to have a protective effect against gonorrhoea and non-gonococcal urethritis and cervical infections similar to that of condoms.

The irritative effect of N-9 on the vaginal mucosa may cause ulcers.[70] Both clinical trials documenting a role of N-9 in genital ulceration or symptomatic irritation[70 72] investigated prostitutes, and may therefore not be representative of the general population. Niruthisard *et al*[94] found that cumulative doses of N-9 caused a high rate of irritation and epithelial lesions of the vagina, but only rare and mild adverse reactions were reported from RCT based on the general population[71 73]. Quite possibly prostitutes experienced a dose-dependent adverse effect which is not applicable to the whole population.

Another open issue is the potential interaction between BMC and spermicides both in terms of roles of separate or combined utilisation, and of separate or combined impact on the subsequent risk of STD.

In conclusion, many studies deal with the effect of BMC on the risk of gonorrhoea and HIV transmission, but results are still scanty for other infections. Few data are available to analyse the comparative effect of condom and diaphragm, and the role of spermicides. In particular, N-9 seems to have different effects on different pathogens.

A final consideration as regards the public health implications of the studies reviewed. A consistent and strong protection may well be acceptable for treatable diseases and rare exposures, but a similar protection is clearly not satisfactory for frequent exposures and, particularly, serious or severe diseases. These data, therefore, offer some guidelines for risk assessment, but should be applied with due caution for any individual choice.

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